NATIONAL WETLANDS INVENTORY MAPPING

Bill O. Wilen, Ph.D.
U. S. Fish and Wildlife Service
Hamilton Building, Room 403
1375 K Street, NW.
Washington, D.C. 20005

INTRODUCTION

The Fish and Wildlife Service has always recognized the importance of wetlands to waterfowl and other migratory birds because 10-12 million ducks breed annually, and millions more overwinter, in the United States. Consequently, the service has a direct interest in protecting wetlands, especially the breeding and overwintering wetlands.

We now know that wetlands also play an integral role in maintaining the quality of human life through material contributions to our national economy (food supply; water supply and quality; flood control; fish, wildlife, and plant resources) and thus to the health, safety, recreation, and economic well-being of all our citizens.

BACKGROUND

The need to consider and use sound ecological information in forming decisions concerning policy, and the planning and operational management of our natural resources, is a well-known concept of longstanding. Despite this, we see many of our ecosystems being altered or adversely affected by pollution as well as by urban, industrial, and agricultural development.

Although short-term economic gain and political expediency are involved in some resource decisions, we believe that the majority of our nation's people, including the policymakers, planners, and managers, would like to do their best for future generations as well as meet our short-term needs. The major problem is simply that the information needed to make environmentally sound decisions is, for one reason or another, either not available or is in a format that cannot be used in the decisionmaking process.

Need For A National Wetlands Inventory

We believe all decisionmakers, including the American public, need information early in their planning processes to make effective decisions. National Wetlands Inventory (NWI) aims to generate and disseminate scientific information on the characterisitics and extent of wetlands. The purpose of this information is to foster wise use of wetlands and to provide data for making quick and accurate decisions about wetlands by knowing how many and what type are where.

DESIGNING THE INVENTORY: PRE-OPERATIONAL PHASE

Prior to actually beginning wetlands mapping, NWI initiated a pre-operational effort to determine the best way to inventory wetlands. During this pre-operational phase, NWI reviewed existing State and local wetlands inventories and existing classification schemes, and then selected a remote sensing technique for their inventory. All this work was done prior to full-scale wetlands mapping (the operational phase) which began in 1979.

Criteria For A Successful Classification System

Based on our review of existing classification systems, we believe that several criteria are fundamental in the development of a successful classification system:

The system must be simple enough that it can be learned and easily applied by a biologist having minimal field experience.

The system must be able to stand alone, independent of the tools of inventory and the scale of the final map product. It must be possible to apply the mapping conventions regardless of the inventory tool chosen. Information on how to obtain copies of the mapping conventions developed by NWI are found in Appendix A.

The classification system must be hierarchical so as to allow for systematic aggregation and disaggregation of the large amounts of data and information. Also, a hierarchical system provides the appropriate level of detail needed to make decisions at several geographic or administrative levels. Data collection starts at the top of the hierarchy and moves down to greater and greater levels of detail. How far down the hierarchy one proceeds depends upon the amount of detail needed and the funds available. As more information is needed, more of the hierarchy can be completed without the need to duplicate what has already been done. If a researcher has a complete set of high resolution data at the local level, this information can be plugged into the base of the hierarchical system and is available for aggregation to higher levels, thus making the information available to the decisionmaker.

The classification system must have building blocks that can be clearly and easily identified by the lay public on the ground or through remote sensing. In the case of the U.S. Fish and Wildlife Service's Classification System, this is the class level. (Cowardin, et al. 1979).

The classification system must be open-ended so as to accept new elements or modifiers as knowledge advances.

The classification system must provide the information that is needed to make value judgments without being an evaluation system. If the classification system had incorporated our present value system, it would be inflexible to increases in knowledge and would over emphasize our present biases. The classification system we structured contains information on water regime, water chemistry, soils, and man's influence, thereby providing the user with the information required to make value judgments based on today's knowledge, but not precluding a different value judgment at a later time, based on a new knowledge of wetlands ecosystems.

Developing A New Wetlands Classification System

Purpose. The purpose of the classification system is (1) to describe ecological units having certain common natural attributes; (2) to arrange these units in a system that will facilitate resource management decisions; (3) to furnish units for inventory and mapping; and (4) to provide nationwide uniformity in wetlands concepts and terminology.

The classification system that was developed defines the limits of wetlands according to ecological characteristics. It DOES NOT define the limits of proprietary jurisdiction of any Federal, State or local government; nor does it establish the geographical scope of the regulatory programs of government agencies.

Definition. A wetland must have enough water at some time during the growing season to cause physiological problems for plants and/or animals not adapted to life in water or in saturated soils. The most precise definition would be based on hydrology, but that would require detailed measurements over periods of time to determine if an area was, indeed, a wetland. Plants and soils furnish a record of the hydrology of a site. Both wetland plants and wetland soils are usually, but not always, present in most wetlands. Plants are not found in wetlands that are subject to drastic fluctions in water level, wave action, turbidity, or high concentrations or salts. Wetland soils are not found on rocky shores, rock bottoms, streambeds, etc. For these reasons, the U.S. Fish and Wildlife Service defines wetlands as:

"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominately hydrophytes, (2) the substrate is predominately undrained hydric soil, and (3) the substrate is saturated with water or covered by shallow water at some time during the growing season of each year."

Structure. The classification system is hierarchical, with wetlands divided among five major systems at the broadest level: Marine, Estuarine, Riverine, Lacustrine and Plaustrine. Each system is further subdivided into subsystems which reflect hydrologic conditions, e.g., subtidal vs. intertidal, in the Marine and Estuarine Systems. Below the subsystem level is the class level, which describes the appearance of the wetland in terms of vegetation (e.g. Emergent, Aquatic Bed, Forested) or

substrate, where vegetation is inconspicuous or absent (e.g., Unconsolidated Shore, Rocky Shore, Streambed.) Each class is further subdivided into subclasses. The classification also includes modifiers to describe hydrology (water regime), water chemistry (pH, salinity and halinity) and special modifiers relating to man's activities (e.g., impounded, partly drained, farmed, artificial). Copies of the classification system are available from the Government Printing Office. The address is found in Appendix B.

Selecting a Remote Sensing System

Due to the magnitude of a national inventory, remote sensing was the obvious technique for inventorying the Nation's wetlands. In 1975, the basic choice was between the high-altitude photography and satellite imagery (LANDSAT). After comparing LANDSAT's capabilities with the the Service's and other agencies' needs for wetlands information, it was evident that LANDSAT could not accurately detect or classify wetlands. A comparison between wetland maps of an area in the Prairie Potholes produced through LANDSAT, and by NWI through high-altitude imagery did not detect 61 percent of the wetlands acreage identified by NWI and could only separate three wetland types, while NWI identified 15 types. This and other studies have shown specific problems with LANDSAT imagery including (1) the fixed orbit does not provide opportunity to capture optimum water conditions for wetland detection; (2) detection of linear and small wetlands; and (5) separating natural ponds from impoundments. Recognizing these drawbacks, the Service chose high-altitude photography as the source for the inventory.

High-Altitude Aerial Photographs

The decision as to what scale of photographs to do the job is critical when taking into consideration the combined cost of air photo acquisition, plotting work areas on the photos, photo interpretation and transferring the annotated information to maps.

For example, Table 1 shows a comparision of the number of aerial photographs required for complete stereoscopic coverage of a U.S. Geological Survey (USGS) 1:100,000 scale map area (1,667 square miles) using 60 percent forward overlap and 10 percent sidelap with various scales of photography. It is essential to select the smallest scale of photography that will do the job to maximize the efficient use of funds.

The use of existing aerial photography can cut the cost of data acquisition to a small fraction of the cost of acquiring new photographs. The Fish and Wildlife Service participates in the Federal High Altitude Aerial Photography Program along with 12 other agencies. These agencies all need the detailed information obtained from the Program's 1:65,000 scale color-infrared photography.

Table 1. The number of aerial photographs required for complete stereoscopic coverage of a USGS 1:100,000 scale map area.

Scale of Photography	Area Covered on One 9"x9" Photo (Sq. Mi.)	Number of Photos
1:2,000	0.1	74,601
1:12,000	2.9	2,255
1:24,000	11.6	630
1:40,000	32.5	260
1:80,000	127.7	84
1:120,000	290.7	50

With this imagery, NWI is mapping wetlands, generally between one to three acres in size, although in the Prarie Potholes the minimum mapping unit may be as small as 1/10 of an acre.

Availability of Imagery. The aerial photographs obtained by the Federal High Altitude Program are available through the U.S. Geological Survey's National Cartographic Information Center (NCIC). The names, address and phone numbers of all NCIC offices are listed in Appendix C.

New Remote Sensing Technologies. Although the NWI project has selected high-altitude photography as its primary remote imagery source, NWI continues to keep abreast of evolving new technologies. The latest generation of satellites, or future satellites, may eventually provide sufficient resolution and accuracy to meet NWI's requirements. Preliminary results of LANDSAT-5 imagery showed improvements in spectral and spatial resolution over previous LANDSAT satellites. NWI is coordinating with NASA on experimental applications of LANDSAT-5 imagery for wetlands mapping, such as Ducks Unlimited's wetlands inventory feasibility study. Regional pilot projects should demonstrate whether or not LANDSAT-5 imagery can be used to accurately map wetlands in various parts of the country. LANDSAT-5 or future satellites, like France's SPOT, may provide NWI with a useful tool for monitoring wetland losses and gains, updating our wetland maps, and even for new mapping efforts in the future.

ORGANIZATION OF NWI

To conduct the NWI, the Service employs a small staff of 26 biologists (assembled into two basic groups: the NWI Central Control Group and Regional Wetland Coordinators) and hires contractors to do photointerpretation, field work and map production. The NWI National Coordinator works out of the Washington, D.C. office and coordinates budget, annual work plans and strategic planning.

Central Control Group

The NWI Central Control Group at St. Petersburg, Florida, is the focal point for all operational activities of the Inventory. It acquires all materials necessary for

performing the survey, and provides technical assistance and work materials to the Regional Coordinators. A private service support contractor is responsible for all map production, and supplies needed personnel (about 100 technicians and professionals). Presently, the Army Corps of Engineers has a person located in St. Petersburg. The U.S. Geological Survey and the Soil Conservation Service have had representatives located in St. Petersburg in the past. Other agencies not representated at the Central Control Group have established formal contact persons who are responsbile for coordination with the NWI. These agency representatives provide the needed expertise that the Fish and Wildlife Service neither has the funds for, nor the ceilings to acquire. They facilitate the collection of existing collateral data from these other Federal agencies to ensure the product developed by the inventory will be usable by their agency, provide unique ideas and insights, and ensure interagency coordination and dissemination of NWI products.

Regional Wetland Coordinators

Regional Wetland Coordinators, located at the Service's seven regional offices, are totally responsible for all aspects of the NWI within their regions and ensuring that NWI products meet Regional needs. They manage contracts for wetlands photointerpretation, coordinate interagency review of draft maps, secure cooperative funding from other agencies, and disseminate NWI products. They are the points of contact for the States and private sectors. A list of their names, addresses, phone numbers and geographical areas of responsibility, by State is found in Appendix D.

Photointerpretation and essential field checking are performed by contractors having regional wetland expertise. These contractors are equally divided between universities, State agencies, private consulting firms, and a few Federal agencies such as the Tennessee Valley Authority. These contractors photointerpret wetlands using stereoscopes, conduct field surveys and examine existing information on a given area's wetlands to ensure accurate identification of those wetlands.

CONDUCTING THE INVENTORY - OPERATIONAL PHASE

The operational phase of the NWI Project involves development of two very different kinds of information: (1) detailed maps and (2) status and trends reports. First, detailed wetlands maps for geographic areas of critical concern are needed for impact assessment of site-specific projects. These maps serve a purpose similar to the Soil Conservation Service's soil survey maps, the National Oceanic and Atmospheric Administration's coastal geodetic survey maps, and the U.S. Geological Survey's topographical maps. Detailed wetlands maps are used by local, State and Federal agencies as well as by private industry and organizations for many purposes including comprehensive resource managment plans, environmental impact assessments, permit reviews, facility and corridor siting, oil spill contingency plans, natural resource inventories, wildlife surveys, and other uses. Secondly, national estimates of the current status and trends (i.e., losses and gains) of wetlands are needed in order to provide improved information for reviewing the effectiveness of existing Federal programs and policies, for identifying national or regional problems, and for general public awareness. In addition to the wetlands maps and the trends report, other products are produced to compliment the mapping effort, including lists of hydric (wet) soils and wetlands plants (hydrophytes), wetland reports, and a computerized wetland values database.

National Wetlands Inventory Maps. Two series of wetlands maps are being prepared: (1) small-scale (1:100,000 or 1:250,000) and (2) large scale (1:24,000). The 1:100,000 scale maps cover approximately 1700 square miles each, and include 32 - 1:24,000 maps or 8 - 1:62,500 maps. They are used chiefly for watershed and regional planning and at present are being produced only in limited areas, when user-funded. The primary map product is the large-scale map which shows the location, shape, and characteristics of wetlands and deepwater habitats on a USGS base map. These detailed maps are excellent for site-specific project evaluation and are the most sought-after map product.

To produce final NWI maps, seven major steps must be completed: (1) preliminary field investigations, (2) photointerpretation of high-altitude photographs, (3) review of existing wetlands information, (4) quality control of interpreted photos, (5) draft map production, (6) interagency review of draft maps, and (7) final map production. High accuracy is achieved because of the NWI technique which involves a combination of field studies, photointerpretation, use of existing information, and interagency review of draft maps.

Wetlands Status and Trends Report. The national wetlands status and trends analysis study arose from the need for national estimates on the current extent of our Nation's wetland resource in the lower 48 States and on corresponding losses and gains over the past two decades. A statistical survay of U.S. wetlands in the mid-1950s and mid-1970s was conducted using conventional air photointerpretation techniques. The status of wetlands in the mid-1950s and mid-1970s was determined and estimates of losses and gains during that interval were computed.

In the mid-1970s the United States (i.e., the lower 48 States) had a total of 99 million acres of wetlands - 5.2 million acres of coastal wetlands and 93.7 million acres of inland wetlands - which amount to only 46 percent of our original wetland acerage. (Roe and Ayres 1953; Frayer, et al. 1983). This is an area approximately the size of the State of California.

Wetlands now represent only about 5 percent of the total land surface of the United States. In the mid-1970s, the U.S. wetland resource consisted of 5.2 million acres of coastal wetlands, 600 thousand acres of inland flats, 4.4 millions acres of ponds, 49.7 million acres of forested wetlands, 10.6 million acres of shrub wetlands and 28.4 million acres of inland marshes. Deepwater habitats in the mid-1970s amounted to 15 million acres of coastal bay bottoms and 57.9 million acres of lakes and reservoirs.

Conversion of wetland to farmland was responsible for 87 percent of wetland losses, while urban development and other development caused 8 percent and 5 percent of the loss, respectively.

Agriculture land development had the greatest impacts on forested wetlands and inland marshes, with losses of 6.2 and 4.6 million acres, respectively. In addition, 1 million acres of shrub swamps were converted to agricultural land by the mid-1970s.

Comparing important water breeding and overwintering areas with areas of greatest loss of inland marshes, we find heavy losses in the Prarie Potholes, Nebraska, and Florida.

Florida's inland marshes are also subject to large-scale agricultural conversion, particularly the Everglades. These wetlands provide feeding areas for many migratory birds and are the breeding grounds for such birds as rails and the Everglades kite. In addition to losing these and other wildlife values, destruction of the Kissimmee River wetlands from channelization has accelerated deterioration of water quality in Lake Okeechobee.

Looking at areas of greatest losses of forested wetlands, we find major destruction of bottomland hardwoods forests in the Lower Mississippi Valley and of North Carolina's pocosin wetlands. "Pocosin" is an Algonquin Indian word for freshwater wetlands. These wetlands are prevalent along the southeastern coastal plain.

Since the mid-1950s, coastal wetland losses were most significant in three states: Louisiana, Florida and Texas. In Louisiana, submergence of coastal wetlands had converted nearly 200 thousand acres to bay bottoms by the mid-1970s. The causes of these changes are numerous and complicated. Rising sea level, coastal subsidence and saltwater intrusion are the main causes. Subsidence is largely due to levee construction along the Mississippi River, which retards marsh building, and to oil and gas extraction, which causes gradual sinking of the coastal plain. Channel construction through the marshes accelerates saltwater intrusion, killing freshwater marsh vegetation. Through photographic interpretation we could not attribute these losses to the influence of man, they were recorded as natural changes from costal wetlands to bay bottoms. Through photograph interpretation, the verifiable man-induced losses were: urban development 92 percent, agriculture 6 percent, and other development 2 percent.

The objective of the status and trends study was to develop reliable national level statistics. The states listed below have significant decreases in one or more kinds of wetlands identified by this national level study.

Intensified State-level sampling would surely show additional States with decreases in wetlands. The national-level study found 19 States with significant net losses in wetlands: (1) in the Northeast - Delaware, Maryland, and New Jersey; (2) in the Midwest - Illinois, North and South Dakota, Minnesota, Nebraska and Wisconsin; (3) in the Southeast - all States, except Virginia, Tennessee and Kentucky; (4) Texas in the Southwest; and (5) California on the West Coast. Information on ordering copies of the scientific and popular reports on the status and trends analysis is found in Appendix B.

Wetand Soils List. To clarify the meaning of "hydric soils" a list of the Nation's hydric soils has been prepared by the Soil Conservation Service (SCS) in cooperation with NWI. Hydric soils are defined as those that experience soil saturation for significant periods, or frequent flooding for long periods, during the growing season. The hydric soils list will be useful for aiding wetland determinations in the field, through use of soil survey maps. State specific lists are available from the National Wetlands Inventory offices in St. Petersburg, Florida.

Wetland Plant List. To clarify the term "hydrophytes," NWI is preparing a list of vascular wetland plants. "Hydrophyte" is defined as "any plant growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water." For purposes of the listing, wetland plants are divided into four indicator categories based on a plant's frequency of occurance in wetlands. These categories are: (1) obligate - always found in wetlands (95%) of the time) (2) facultative wet - usually found in wetlands (66-95 percent of the time) (3) facultative - sometimes found in wetlands (33-66%) and (4) facultative upland - seldom found in wetlands (33%). The NWI is creating a wetland plant database that not only includes the list of hydrophytes, but also contains information such as the plant's ecology, geographic distribution, common names, and indicator status. Of an estimated 5,300 species of plants believed to occur in U.S. wetlands, 4,000 have been entered into the database. Meanwhile, an interim national list of all the vascular hydrophytes is available.

Wetland Reports. Two basic types of wetland reports have been developed by NWI: map reports and State wetland reports. The map reports briefly outline NWI procedures and findings (e.g., lists of wetland plant communities and photointerpretation problems). Map reports are available for numerous areas. By contrast, the State wetland reports are comprehensive publications on the results of NWI for each State. They are prepared upon completion of the wetlands inventory in each State. The State reports include wetland statistics and detailed discussions of NWI techniques, wetland plant communities, hydric soils and wetland values. State reports are available for New Jersey and Delaware. In the near future, NWI expects to prepare reports for Rhode Island, Massachusetts, and Vermont when wetland statistics become available.

Wetland Values Database. NWI is building a wetland values database to help pull together information on the functions and values of wetlands contained in the diverse and scattered scientific literature. The database consists of geographically referenced abstracts of scientific articles and reports addressing wetland values, including use, habitat, water quality, hydrology, food chain, and recreation/conservation. The database will help accurately assess State wetland values, aid in developing priorities for wetland protection, and assist in identifying the significance of wetland acreage losses from a value perspective at a local or State level. Currently, the database contains approximately 5,000 articles. A goal of 6,000 bibliographic entries by October 1, 1987 has been set.

Each bibliographic source in the database includes the following information: author; year; title; source; abstract (up to 2,100 characters); subject or wetland value; relevant hydrologic unit (as indicated by the U.S. Geological Survey/Water Resource Council hydrologic unit maps); ecoregion (according to Bailey 1976); landform (as defined by Hammond 1964); land surface form; location; relevant U.S. Army Corps of Engineers Districts; and wetland type (following the classification system used for wetland mapping).

The database can be searched for a number of these fields of information producing very specific types of articles. Several examples are: all articles pertaining to flood control and storm dampening in a given State; all publications that focus on estuarine habitat values, especially fisheries; or all articles in the Bailey's prairie and grassland ecoregions that address waterfowl habitat value.

Further information on the database and how it can be accessed is provided in Appendix E.

STATUS OF MAPPING

Priority Setting

Mapping priorities are based principally on the needs of the Service and cooperating Federal and State agencies. The top priority areas are the coastal zone, including that of the Great Lakes, the prairie wetlands and the floodplains of major rivers, comprising approximately 83 percent of the conterminous United States; and 45 percent of Alaska. Priority areas were identified through an analysis of areas used for breeding, transmigration, and wintering by migratory waterfowl; areas used by high interest species, such as endangered and threatened species; areas used for special fish and wildlife resource management, such as refuges; areas where a sound wetland information base would reduce conflicts; and in priority areas of cooperating Federal and State agencies.

The actual mapping of priorities depends on the practical considerations of available photography, cost sharing by another Federal agency or State, and whether wetland maps can be completed in time to assist with ongoing projects. Ongoing acceptable photographs for the Prairie Potholes have been particularly difficult to obtain because of the need to capture optimum water conditions. Consequently, NWI has established a special agreement with NASA to provide this photography.

Current Mapping

As of September 30, 1986, NWI will have produced 10,000 highly detailed maps covering 45 percent of the lower 48 States and 12 percent of Alaska. This includes roughly 85 percent of the coastal zone of the lower 48 States, including the Great Lakes Region. Mapping is complete for eight States: Massachusetts, Rhode Island, Vermont, Arizona, Connecticut, New Jersey, Delaware, and Hawaii, and is underway in all the rest of the United States.

Current information on the exact status of wetlands mapping in any given State is available by contacting the appropriate Regional Wetland Coordinator. Names, addresses and phone numbers of these coordinators are listed in Appendix D or calling 1-800-USA-MAPS.

Future Plans

NWI plans to produce wetland maps for an additional 5 percent of the lower conterminous United States and 2 percent of Alaska annually. At these rates, about 55 percent of the continental U.S. and 16 percent of Alaska will have been inventoried by 1988.

Special Map Production Support

The National Wetland Inventory has a special map production support section that makes specialty maps on a user-pays basis.

1:100,000 Scale Maps. Over 260 1:100,000 scale maps have been prepared by the National Wetland Inventory. They are produced by photographically reducing the 32 - 7.5-minute or eight 15-minute quad sheets that cover the area of the given 1:100,000 scale map. The map is approximately 2 feet by 3 feet in size and covers an area of approximately 1850 square miles.

These maps are useful for area-wide, county-wide or basin-wide planning, initial alignment of roads or pipelines, general overview of the wetlands, displaying alternative project sites and to display trends in cumulative impacts.

1:250,000 Reconnaissance Survey Maps of Florida. During 1982, the NWI completed and had published fifteen National Wetlands Reconnaissance Survey Maps at a scale of 1:250,000. These reconnaissance survey maps, the first of their type, covered the State of Florida. They were the result of a cooperative effort with the USDA, and the Soil Conservation Service which provided the funding. Nine of these maps inventoried 34,200 square miles of wetlands for the first time in an area of Florida not previously mapped by NWI. The other six of the maps updated previously inventoried areas. Since 1982 NWI has produced fifteen more 1:250,000 scale maps in Nevada.

1:500,000 Scale Wetland Map of Florida. This map was prepared for the Jacksonville District Corps of Engineers to provide an overview of the major wetland resources of Florida. it was accomplished by photo-reducing and recompiling of the 1:250,000 Wetlands Reconnaissance Survey Maps that NWI had prepared for the U.S. Soil Conservation Service. Copies of the map are available at the St. Petersburg office of NWI.

Map Dissemination

Approximately 488,000 copies of draft and final maps have been distributed by the National Wetland Inventory and through the United States Geological Survey's National Cartographic Information Center. Names, addresses and phone numbers of the National Centers are listed in Appendix C. The number of maps distributed through the State-run centers is unknown. The names, addresses and phone numbers of these centers are listed in Appendix F.

Uses of the Wetland Maps

On each of our large scale maps we have a Special Note, which states in part:

"Special Note:

This document was prepared primarily by stereoscopic analysis of high-altitude aerial photographs. Wetlands were identified on the photographs based on vegetation, visible hydrology, and geography in accordance with Classification of Wetlands and Deepwater Habitats of the United States (An Operational Draft), Cowardin, et al., 1977. The aerial photographs typically reflect conditions during the specific year and season when they were taken. In addition, there is a margin of error inherent in the use of the aerial photographs. Thus, an on-the-ground and historical analysis of a single site may result in a revision of the wetland boundaries established through photographic interpretation. In addition, some small wetlands and those obscured by dense forest cover may not be included on this document.

Federal, State and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, State or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within, or adjacent to, wetland areas should seek the advice of appropriate Federal, State or local agencies concerning specific agency regulatory programs and proprietary jurisdictions that may affect such activities."

There are probably 100 different uses of the wetland maps. The following is a list of documented uses:

research, teaching, reference, regulatory and jurisdiction, permit review, legislation, litigation, flood control, protection management, waste treatment (solid and water), oil-spill planning, environmental assessment, environmental impact statements, land-use planning, town planning, highway design and planning, regional/State planning, resource assessments/trade-offs, land-use guides/policies, watershed and river basin planning, energy resources, identification, inventory, evaluation, classification, conservation, protection management, land acquisition, wildlife habitat management, water quality planning, watershed planning, river basins planning, enforcement, collateral data for detailed soils surveys, wetland values, project siting studies, wetland value methodology, wetland value research, rural electrification loans, soil and water conservation loans, wetlands mitigation, property tax relief, zoning, flood hazard planning, wetland change detection, cumulative impacts, prioritizing field review, assisting in a field review, assisting with compliance with the Wetlands Protection Executive Order.

Computer-Assisted Mapping. NWI is involved with computer assisted mapping technology. Although not presently cost effective on a nationwide basis, computer mapping is being alternately pursued and advanced by NWI through the fields of digitization, computer graphics and analytical photogrammetry. In working with groups such as the Defense Department's Computer-Assisted Photo Interpretation Lab and the Service's Western Energy and Land Use Team, NWI will ensure that it moves operationally into these fields as soon as it is cost effective.

Status of Digital Data

These data are available for the States of New Jersey and Delaware, Maryland, the Lower Columbia River Basin, hard-rock mining areas of Minnesota, Kenai Peninsula in Alaska, and an area adjacent to the Great Salt Lake of Utah. Work in progress includes the State of Illinois,

the Nebraska Sandhills, a portion of the prairie potholes and a portion of the north slope of Alaska.

Future Direction

The data will be supplied to users on magnetic tape in a fairly simple polygon format and in most common map projections. Special data reformatting to suit a particular geographic information system is available, at cost, to the user. For States using geographic information systems in planning, impact assessment or information retrieval, making this data available in a digital form will help ensure that NWI maps will continue to be used. In addition, because NWI will do the data conversion work, we will be able to enforce the same quality control procedures and expertise used in our conventional mapping, thereby ensuring a uniform, quality product. By using the digital data to produce a classical NWI map that will be run through NWI's normal cartographic quality control procedures, we will be able to identify and correct the erroneous digital data that plague many databases or go unnoticed for years. To date, NWI has supplied data to the States of Minnesota, New Jersey, Oregon, Maryland, and Nebraska, and has plans to supply data to Illinois, Indiana, and Alaska. Interest has been expressed by several other States. It has always been the goal of NWI to supply products that best meet the needs of the user. We feel that as more States move to take advantage of geographic information systems and other computer technologies, providing our products in a form compatible with these technologies will be the best way to meet the user needs.

REFERENCES

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe 1979, Classification of Wetlands and Deepwater Habitats of the United States, U.S. Fish and Wildlife Service, FWS/OBS-79/31, 103 pp.

Frayer, W.E., T.J. Monahan, D.C. Bowden and F.A. Graybill 1983, Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States: 1950s to 1970s, Department of Forest and Wood Sciences, Colorado State University, Ft. Collins, 32 pp.

Roe, H. B. and Q. C. Ayres 1954, Engineering for Agricultural Drainage, McGraw-Hill Book Col., New York, 501 pp.

Shaw, S.P. and C.G. Fredine 1956, Wetlands of the United States Their Extent and Their Value to Waterfowl and Other Wildlife, U.S. Fish and Wildlife Service, Circular 39, 67 pp.

Tiner, R.W. 1984, Wetlands of the United States: Current Status and Recent Trends, U.S. Fish and Wildlife Service, 57 pp.

U.S. Department of Interior 1976, Existing State and Local Wetlands Surveys 1965-75, U.S. Fish and Wildlife Service, 453 pp.

APPENDIX A

MAPPING CONVENTIONS

The Classification of Wetlands and Deepwater Habitats of the United States was designed to stand alone, independent of the tools of inventory and the scale of the final map product. It can be used on the ground or with high-altitude aerial photographs. When a tool of inventory is selected, mapping conventions must be developed. Once a tool such as aerial photography at a given scale is selected, the minimum size unit and degree of detail attainable is set.

It is necessary for the user to develop a specific set of mapping conventions for each application and to demonstrate their relationship to the classification. For example, there are a number of possible mapping conventions for a small wetland basin 50 m (164 feet) in diameter with concentric rings for vegetation about the deepest zone. At a scale of 1:500 each zone may be classified and mapped; at 1:20,000 it might be necessary to map the entire basin as one zone and ignore the peripheral bands, and at 1:250,000 the entire wetland basin may be smaller than the smallest mappable unit, and must be supplemented by information gathered by sampling. In other areas, it may be necessary to develop mapping conventions for taxa that cannot be easily recognized; for instance, Aquatic Beds in turbid waters may have to be mapped simply as Unconsolidated Bottom. These mapping conventions are also available. For copies you may contact:

NATIONAL WETLANDS INVENTORY GROUP

U.S. Fish and Wildlife Service
Monroe Building - Suite 101
9720 Executive Center Drive
St. Petersburg, Florida 33702

Telephone: 8-826-3624 (FTS)
813-893-3624 (Comm)

APPENDIX B

Classification System

Copies of the "Classification of Wetlands and Deepwater Habitats of the United States" are available from the Superintendent of Documents by writing to:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

The Stock number is 024-010-00524--6 and the cost is $6.00.

Scientific Report on Status and Trends Analysis

The publication entitled Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950's to 1970's reports on all the results and procedures used in the study. It is available for $5.00 from:

Department of Forest and Wood Services
Colorado State University
Fort Collins, Colorado 80523

Popular Report on Status and Trends Analysis

The U.S. Fish and Wildlife Service produced a popular report entitled "Wetlands of the United States: Current Status and Recent Trends," to inform the general public, government agencies, private industry and others about the present status of U.S. wetlands. This publication is also available by writing the Superintendent of Documents.

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

The Stock number is 024-010-00656-1 and the price is $3.00.

APPENDIX C

To order NWI Maps or national high-altitude program aerial photographs call or write one of the following National Cartographic Information Center (NCIC) offices:

NATIONAL HEADQUATERS

National Cartographic
Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092
Phone: (703) 860-6046
FTS: 928-6045

TOLL FREE: 1-800-USA MAPS

Regional Offices

National Cartographic
Information Center
U.S. Geological Survey
National Space Technology
Laboratories
Building 3101
NSTL Station, Mississippi 39529
601-688-3644
FTS: 494-3544

Western Mapping Center-NCIC
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025
415-323-BILL, ext. 2427
FTS: 467-2427

Mid-Continent Mapping Center-NCIC
U.S. Geological Survey
1400 Independence Road
Rolla, Missouri 65401
314-341-0851
FTS 277-0851

Rocky Mountain Mapping Center-NCIC
U.S. Geological Survey
Box 25046, Stop 504 Federal Center
Denver, Colorado 80225
303-236-5829
FTS 776-5829

National Cartographic Information Center
U.S. Geological Survey
Skyline Building
218 E. Street
Anchorage, Alaska 99501
907-271-4159
FTS 271-4159

FEDERAL AFFILIATE NCICs

Tennessee Valley Authority
200 Haney Building
311 Broad Street
Chattanooga, Tennessee 37401
615-751-2148
FTS: 858-2148

ORDERING INSTRUCTIONS

The U.S. Fish & Wildlife Service's National Wetlands Inventory (NWI) and the National Cartographic Information Center (NCIC) have a cooperative agreement for the sale and distribution of NWI maps. NCIC offices accept orders for NWI maps by phone or mail. Map orders are entered into a computer system called INORAC. The NWI office in St. Petersburg, FL accesses INORAC on a weekly basis to obtain these orders. NWI's Service Support contractor reproduces and ships the maps within 5 working days of receipt of the orders.

Call or write one of the NCIC offices on the attached list or call 1-800-USA-MAPS, NCIC's toll free number to order NWI maps.

Have the following information at hand before calling:
- Map Name (1:24,000, 1:62,500 or 1:100,000 scale USGS series quadrangles)
- State and county name
- Latitude/longitude coordinates of map area, if known

Costs:

$6.50 - shipping and handling charge, per order

$3.50 per map - Mylar overlay or composite (1:24,000, 1:62,500, 1:63,360, or 1:100,000)

$1.75 per map - Paper overlay or composite (1:24,000, 1:62,500, 1:63,360, or 1:100,000)

OVERLAY - NWI delineations only

COMPOSITE - NWI delineations and USGS topographic base combined photographically

APPENDIX D

NWI Maps are available from the U.S Fish and Wildlife Service's Regional Wetland Coordinators

Geographical Area	Regional Wetland Coordinator
California, Hawaii, Idaho Nevada, Oregon, Washington	Dennis Peters U.S. Fish and Wildlife Service Lloyd 500 Bldg, Suite 1650 500 N.E. Multnomah Street Portland Oregon 97232 503/231-6154 FTS 429-6154
Arizona, New Mexico, Oklahoma, Texas	Warren Hagenbuck U.S. Fish and Wildlife Service P.O. Box 1306 Albuquerque, NM 87103 505/766-2914 FTS 474-2914
Illinios, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin	Ron Erickson U.S. Fish and Wildlife Service Bishop Henry Whipple Federal Building, Fort Snelling Twin Cities, MN 55111 612/725-3536 FTS 725-3536
Alabama, Arkansas, Florida Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virgin Islands	John Hefner U.S. Fish and Wildlife Service R.B. Russell Federal Building 75 Spring Street, SW. Atlanta, Georgia 30303 404/221/6343 FTS 242-6343
Conncecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennyslvania, Rhode Island, Vermont, Virginia, West Virginia	Ralph Tiner U.S. Fish and Wildlife Service One Gateway Center, Suite 700 Newton Corner, MA 02158 617/965-5100, ext. 379 FTS 829-9379
Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming	Charles Elliott U.S. Fish and Wildlife Service P.O. Box 25486, Denver Federal Center Denver, Colorado 80225 303/776-8180 FTS 776-8180

Alaska

Jon Hall
U.S. Fish and Wildlife Service
1011 East Tudor Road
Anchorage, Alaska 99503
907/786-3403
FTS 907-786-3403

APPENDIX E

For further information on accessing the wetland values database, please contact:

Patricia J. Ruta Stuber, Database Administrator
USDI Fish and Wildlife Service
Western Energy and Land Use Team
Creekside One Building
2627 Redwing Road
Fort Collins, Colorado 80526-2899
303/226-9100
FTS 323-5390

The wetland values database is an easily searchable compilation of scientific articles and publications that address one or more wetland values. To be included in the database, the literature must address one of the following wetland values: use values (forage, agricultural crop, hunting/fishing, irrigation, wastewater treatment, cultural, aesthetic, heritage, timber, education, scarcity/uniqueness, special set-aside areas, research, recreation, archaeological, open space, energy, medicinal, indicator species, water supply, aquaculture, monetary assessment, and other industry); habitat values (fisheries, waterfowl, amphibians, reptiles, insects/invertebrates, shellfish, mammals, furbearers, shore birds and non-game birds); water quality values (heavy metals, thermal effluent, sediment trapping, oxygen production, nutrient sink, organic acids, and toxins); hydrologic values (erosion control, flood control, storm dampening, groundwater recharge, groundwater discharge, flow stabilization, and salt water intrusion); food chain values (primary production, secondary production, nutrient export, nutrient cycling, grazing pathway, detritus pathway, and detritus production); secondary consumption; general values; wetland value assessment techniques; economic models; and other wetland values bibliographies.

APPENDIX F

State Distribution Centers for Wetlands Maps

Alabama:
Geological Survey of Alabama
420 Hackberry Lane
P.O. Box O, University Station
Tuscaloosa, Alabama 35486
(205) 349-2852

California:
CA Dept. of Fish and Game
Natural Heritage Section
1416 Ninth Street
Sacramento, California 95814
(916) 322-2493

Connecticut:
Department of Environmental Protection
Natural Resources Center
State Office Building
Hartford, Connecticut 06115
(203) 566-3540

Deleware:
State of Delaware
Department of Natural Resources and
Environmental Control
Wetlands Section
Edward Tatnall Building
P.O. Box 1401
Dover, Delaware 19903
(302) 736-4691

Guam:
Director
Bureau of Planning
Government of Guam
Agna, Guam 96910

Hawaii:
Board of Land and Nat'l Resources
Division of Forestry and Wildlife
Technical Service in Wildlife Section
P.O. Box 621
Honolulu, Hawaii 96889

Maine:
Maine Geological Survey
Maine Station 22, State House
Augusta, Maine 04333
(207) 289-2801

Maryland:
Maryland Dept. of Natural Resources
Wetlands Division
Water Resources Administration
Tawes State Office Building
Annapolis, Maryland 21401
(301) 269-3871

Massachusetts:
MA Assc. of Conservation Comm.
Lincoln Filene Center
Tufts University
Medford, Massachusetts 02155

Mississippi:
Technical Transfer Office
Building 11000
NSTL Station,
Mississippi 39529
Comm: 688-3008
FTS: 494-3008

Nebraska:
Dr. Vincent Dreezen, Director
Conservation and Survey Division
University of Nebraska
113 Nebraska Hall
Lincoln, Nebraska 68588-0517

New Hampshire:
Office of State Planning
State of New Hampshire
2-1/2 Beacon Street
Concord, New Hampshire 03301
(603) 271-2155

New Jersey:
NJ Dept. of Environmental Protection
Bureau of Collections and Licensing
Maps and Publications
CN-402
Trenton, New Jersey 08625
(609) 292-2578

New York:
CLEARS
Resource Information Laboratory
464 Hellister Hall
Cornell University
Ithaca, New York 14853
(607) 256-6520

Oregon:
Oregon Department of Fish and Wildlife
506 Southwest Mill Street
Portland, Oregon 97208
(503) 229-5249

Pennsylvania:
Coastal Zone Management
Office of Resource Mgmt.
Department of Environmental Resources
P.O. Box 1467
Harrisburg, Pennsylvania 17120

Rhode Island:
Department of Environmental Management
Freshwater Wetlands Section
38 State Street
Providence, Rhode Island 02908
(401) 277-6820

Vermont:
Vermont Dept. of Water Resources
Montpelier,Vermont 05602
(802) 828-2761

Washington:
Chief Cartographic
Washington Department of Ecology
Mail Stop PV-11
Olympia, Washington 98504
(206) 459-6201